FACTSHEET

October 2015 # 011

BOTTOM AERATION

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Introduction

The use of aeration during wastewater treatment increases the amount of dissolved oxygen (DO) in the effluent. The oxygen added helps to increase the bacterial population which encourages biological and chemical decomposition processes. Bottom aeration in tanks and ponds uses compressed air to add oxygen to wastewater. It can also be used to promote mixing of wastewater in various treatment processes such as coagulation and flocculation addition or filtering systems.

Description

Bottom aeration is known by several different names including diffused aeration, lakebed aeration, and destratification systems, however, the process is the same (Coke, 2008). A compressor is used to pump air down to an air release system located at the bottom of a tank or pond.

A diffuser is weighted or mounted in one location to deliver oxygen to a specific section of the tank (Figure 1). They can be used singularly or in series to cover greater areas of the tank. A weighted air hose is used to deliver oxygen from a compressor located on the surface down to the diffuser unit. Bubbles are released that range in size from fine (1mm to 3mm) to course (5mm to 12mm) through a perforated tubing or porous stone (Stenstrom and Rosso, 2010). As the bubbles travel to the surface they create a synergistic airlift effect, bringing the water to the surface (Pentair, 2014). Once at the surface, the gases present in the lower water are exchanged for atmospheric oxygen which facilitates aerobic digestion (Pentair, 2014).

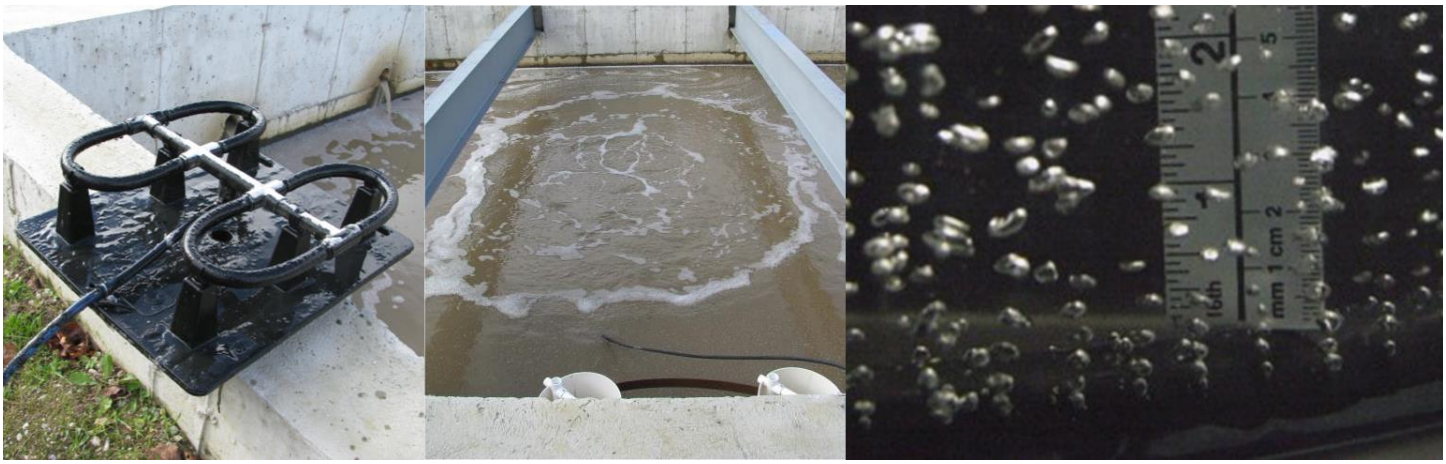

Figure 1: (from left to right) bottom aeration diffuser, surface disturbance by diffuser, and a bubble curtain streaming up from weighted tubing. (Left and middle: HMGA Water Project, right: Canadianpond.ca Products Ltd.)

There are two ways of measuring the efficiency of an aeration system, Standard Aeration Efficiency (SAE) and Standard Oxygen Transfer Efficiency (SOTE). SAE is measured in pounds of oxygen per horsepower unit delivered per hour (lb O_2/hp·hour) and it is often used to compare the operating costs of various aerators. A higher SAE value means a more efficient system. SOTE is measured as a percentage and is primarily based on the size of the bubbles generated; the smaller the bubble size, the more efficient the system. A smaller bubble is more efficient at transferring oxygen due to the ratio of surface area to volume and its slower speed at which it rises (Hill, 2014). A higher SOTE value depicts a higher efficiency rating.

The efficiency of a diffuser system increases with greater tank depth as shown in Figure 2. Their use is not recommended for ponds or tanks less than 2.5 to 3 m (8 to 10') deep (Coke, 2008; ADS, 2014). In shallow ponds, more diffusers are necessary to ensure that there are no undisturbed areas or dead zones. The depth of the diffuser unit determines how much area will be impacted by the aeration (Pentair, 2014). A deeper water column creates a longer contact time of air bubble and water, thus more oxygen from the bubble is transferred to the water before reaching the surface. Fine bubble diffusers (bubbles <3mm) that operate in deep ponds generate SAE values of approximately 15lbs of O_2/hp·hour. Diffusers in shallow ponds are relatively ineffective, as the bubbles rise to the surface too quickly to allow proper oxygen transfer. At depths of 3 to 4 feet, SAE values display results of 1 to 3lbs of O_2/hp·hour (Tucker, 2005). In addition, improperly engineered systems may not effectively aerate the entire tank and can result in the creation of dead zones.

A system relying on diffusers to add oxygen to water may not require the entire tank to be aerated but dead zones will still appear in areas where oxygen is not present. Perforated

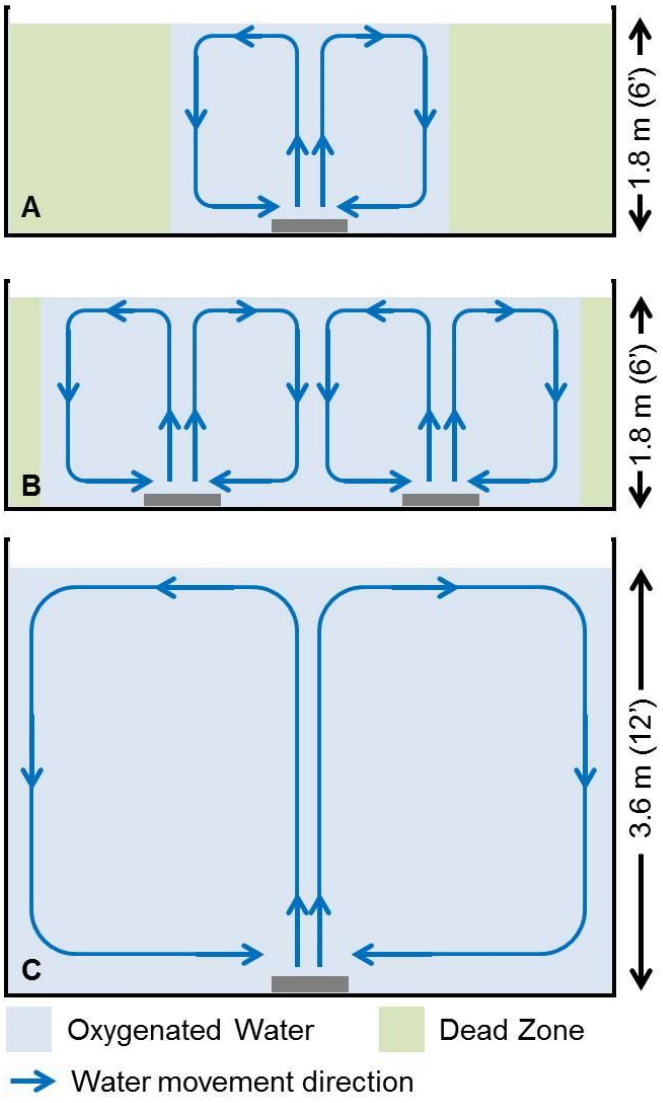

Figure 2: Generalized diagram of bottom aeration diffuser units in different depth settling tanks: (A) Shallow settling tank with a bottom aerator showing the dead zones created by insufficient aeration (B) Adding a second unit into the same tank still leaves dead zones (C) A settling tank with the same surface area but twice the depth requires only one unit to aerate the entire tank.

tubes that run perpendicularly to the inlet of the tank to create a curtain of bubbles that will oxygenate the water as it passes through the area (Figure 1). However, like a diffuser, it is more efficient at transferring oxygen the deeper it is placed (Canadianpond.ca Products Ltd.).

System Placement

Aeration is best utilized in a multi-celled pond system. Ideally, the first cell of the system would allow suspended particles to settle out. The second cell would be the best positioning for an aerator. By introducing oxygen to the second cell, aerobic bacteria would be able to further break down any small particles still in suspension. This would be followed by settling to remove the solids created from the biological activity.

If a multi-celled system is not an option, the use of baffles to create separate zones for settling between the inlet and outlet are necessary to allow settling, aeration, and final settling zones. They need to be engineered in such a way as to avoid mixing.

Considerations

The existing water treatment system or planned treatment segments dictates which method of aeration will be the most effective. Oxygen can also be added through surface aeration and when choosing between systems, there are several factors to be considered such as SOTE and SAE values, power usage, and established and required infrastructure.

Bottom aerators provide oxygen uniformly throughout the water column. Oxygen is supplied at the sludge-water interface with bottom aeration and allows for aerobic decomposition which is preferable over anaerobic decomposition as it is seven times faster.

However, the settling tanks commonly used in existing vegetable wash water treatment systems are relatively shallow, thus bottom aeration is not necessarily the most efficient system for adding oxygen. Diffuser systems will have lower efficiency in shallow tanks. They do add oxygen uniformly throughout the whole water column, but they can still be used with proper configuration.

Performance

The HMGA Water Project tested the bottom diffuser pictured in Figure 1 in a shallow

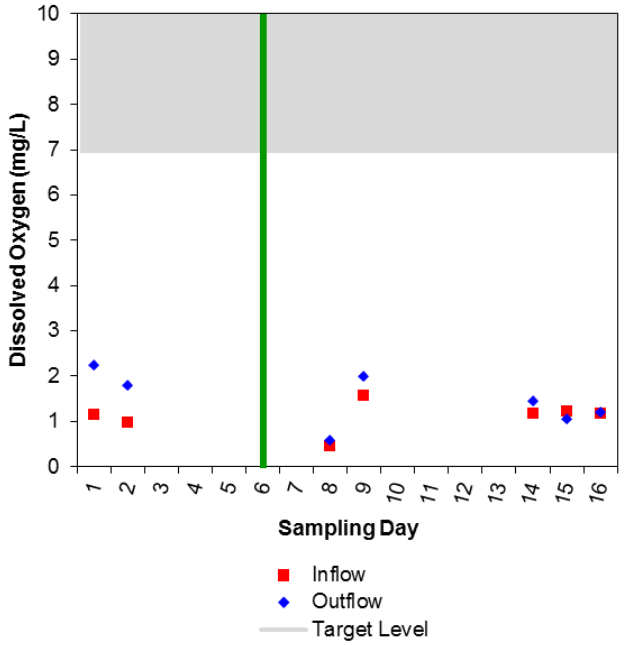

Figure 3: Dissolved oxygen concentration in a settling tank over time before and after diffuser installation at a depth of 1.5m, as shown by the green line, with a target level of 7-10 mg/L (CCME, 1999) (HMGA Water Project)

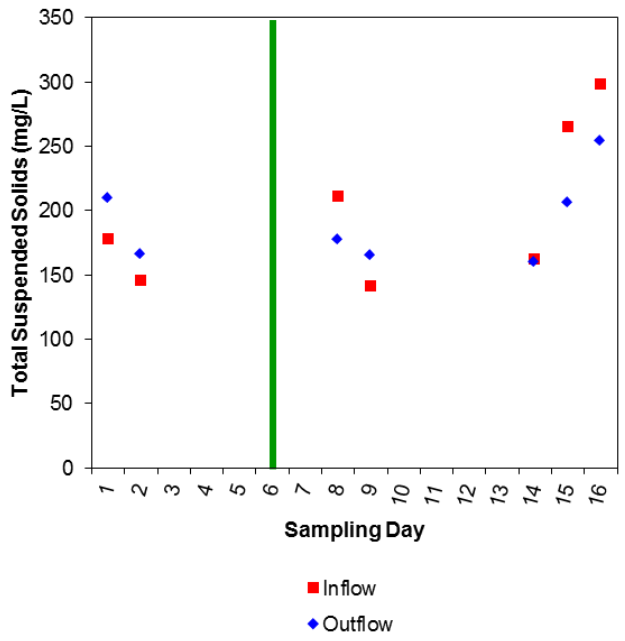

Figure 4: Total suspended solids in a settling tank over time before and after diffuser installation at a depth of 1.5m, as shown by the green line (HMGA Water Project)

tank (1.5m (5') depth). The dissolved oxygen (DO) and total suspended solids (TSS) concentrations before and after the installation of aeration are shown in Figures 3 and 4. It was found that the DO content did not increase, however, the TSS did increase. The three diffusers were insufficient to aerate the entire tank; more diffusers would be required to provide better results. Ultimately, it was determined that the pond was too shallow with too few aerators.

Cost

An aeration system will have capital costs for diffusers, air compressors, hoses, and associated installation costs. There will also be on-going electricity costs to run the compressor.

Conclusion

Bottom aeration is an efficient and effective means of introducing oxygen to a wastewater tank. It promotes oxygen transfer and aerobic digestion of particles and other soluble materials by bacteria. Bottom aeration is best applied to deeper tanks (2.5 to 3m deep). It is essential for the aeration system to be properly sized and placed in order to maximize efficiency.

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This factsheet was prepared by Michael Saunders and Bridget Visser on behalf of the Holland Marsh Growers' Association Water Project. This project was undertaken with the financial support of the Government of Canada through the federal Department of the Environment. Ce projet a été réalisé avec l'appui financier du gouvernement du Canada agissant par l'entremise du ministère fédéral de l'Environnement.